Space Weather Technical Forecast

Issued on Friday, 13 January 2023 at 13:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares (R1-R2 radio blackouts) expected. Chance of X-class (R3 radio blackouts). No significant geomagnetic activity expected.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low or Moderate, with three low level M-class flares, and a M3.9 flare from the vicinity of AR3181 at 13/1015UTC. This region also appears to have produced a long period, high energy C-class flare, which resulted in a CME at approximately 12/2200UTC. This CME is currently being analysed for a potential Earth-directed component. The remaining M-class flares all emanated from either AR3181 or AR3182 in the southwest quadrant, but no further CMEs were observed. The only significant development from any of the complex regions on the visible disc, is from AR3186 which has redeveloped a delta region in the centre of the group. Two new regions, on the northeast and southeast limbs are emerging onto the visible disc and are likely to reveal greater complexity through the next few days. Aside from the CME indicated above, no new Earth-directed CMEs have been identified on available imagery.

Solar Wind / Geomagnetic Activity: Solar wind speeds observed at L1 appear to be indicating a decisive move out of the high speed stream from coronal hole 62, with speeds falling from 400km/s to 350km/s in a short period of time. Density has shown a steady decline over the period, falling from above average to average levels. Magnetic field strength was close to moderate levels until approximately 13/1130UTC when it fell sharply to weak levels. The north-south component has varied weakly throughout, but with a weak but sustained negative orientation between 13/0400UTC and 13/1200UTC. Phi angle was predominantly negative (towards the Sun) throughout. Geomagnetic activity was Quiet with one Unsettled interval.

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 was mostly at background levels. High energy electron flux (greater than 2 MeV) was at background to moderate levels. The 24-hour integrated electron fluence stayed well below the Active threshold on a generally steady trend, reaching 2.7e6 integrated pfu at 12/2359 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be at Low to Moderate levels through the forecast period, as regions rotating off the western limb are replaced by further complex regions on the eastern hemisphere. There is a continued risk of X-class flaring.

Solar Wind / Geomagnetic Activity: There is a risk that a CME which left the northwest of the Sun on 11 January may glance the Earth on 15 January, but with low confidence in arrival and associated impacts. A further CME from the southwest quadrant is being analysed for a potential Earth-directed component. The Earth is leaving the high speed stream from coronal hole 62 with generally background speeds expected through the next four days, although this is subject to the influence of any CME arrivals. Generally Quiet conditions forecast, with a slight chance of Active or G1/Minor Storm intervals from any CMEs.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at predominantly background with a chance of minor levels, due to the risk presented from two complex regions in the southwest quadrant, one with a recent history of a proton rich flare and CME. There is also the risk from two regions in the eastern quadrant. The high energy electron flux (greater than 2 MeV) is expected to continue at background to moderate levels, with the corresponding electron fluence remaining below the Active (1e8 integrated pfu) threshold.

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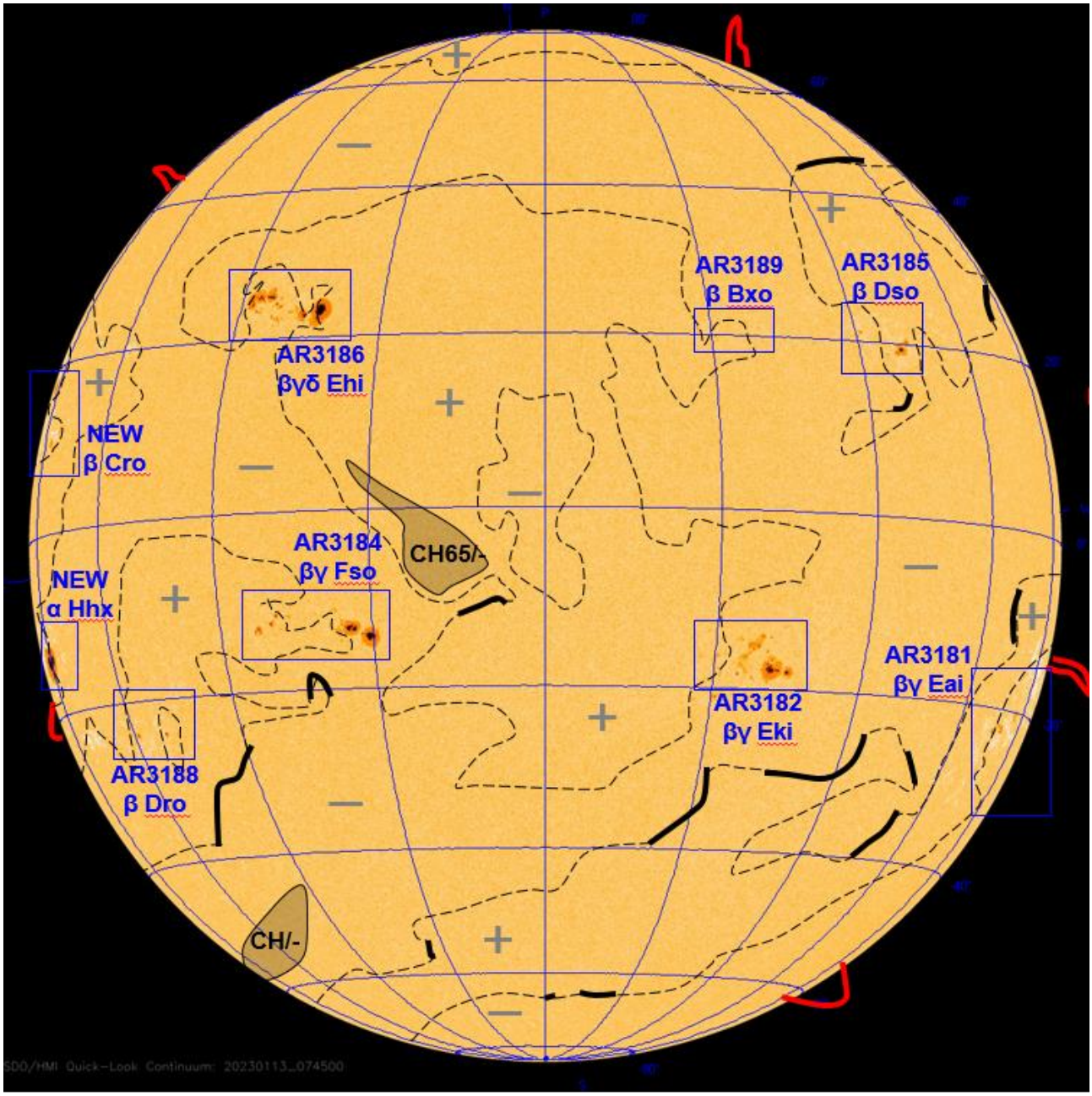
Figure 1. Solar Analysis Valid 13/0800UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 09 January is likely to have missed the Earth. There was some signs of agitation in the magnetic field on 12 January, but the source of this is uncertain. A large CME which left the western limb of the Sun late on 12 January has undergone a reanalysis, following an initial analysis early on 13 January using up to date data to determine whether this may glance the Earth. A CME which left the Sun early on 11 January may glance the Earth on 15 January, but with low confidence.

The Earth is gradually moving out of the high speed stream from coronal hole 62, with no coronal hole high speed streams forecast through the next four days. Coronal hole 65, analysed as a weak feature in the eastern quadrant, is forecast to connect on 17 January and as a weak feature is unlikely to generate significant geomagnetic activity.

Geomagnetic activity is expected to be mainly Quiet with a low risk of Active or G1/Minor Storm intervals on 15 January due to a CME which left the Sun on 12 January.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	1	10	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
12/0939	Partial	AR3185	NW quadrant	500-550km/s	15/1200	Glancing possible. Low confidence

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Figure 2: recent solar wind parameters from L1

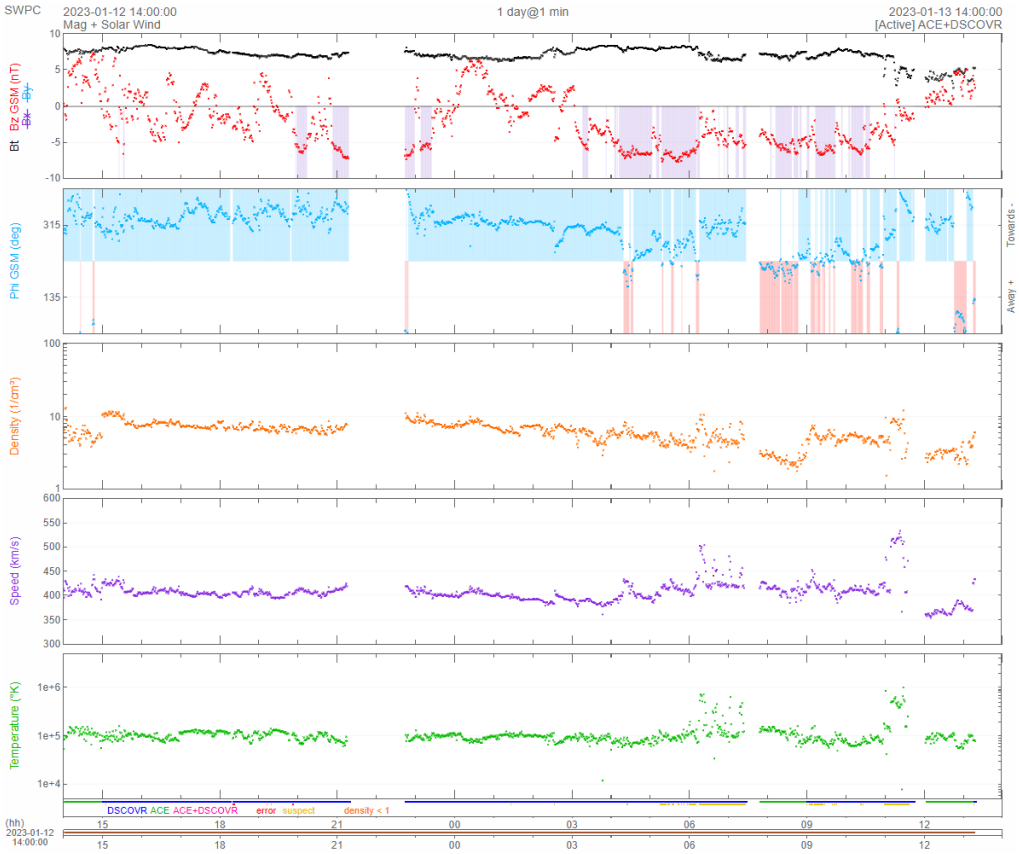
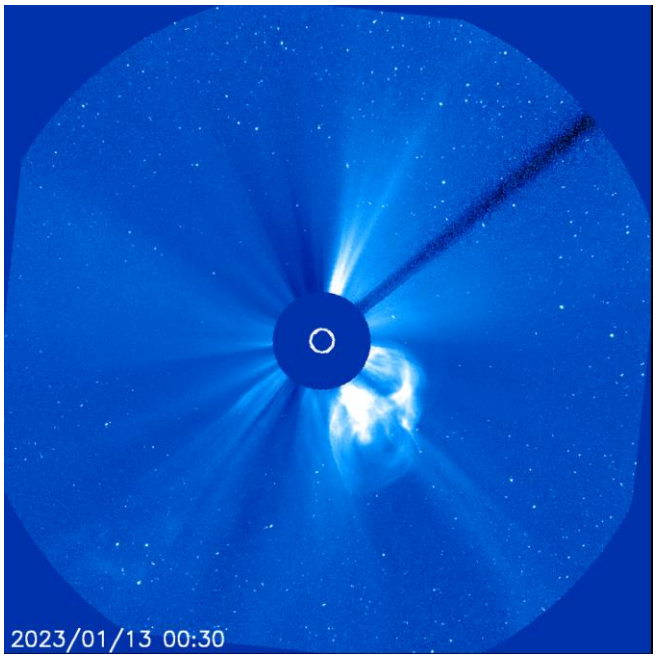


Figure 3: Large CME from SW limb around 12/2200UTC in LASCO C3 imagery



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Radio Blackouts - X-Ray Flares:

There are seven numbered active regions on the visible disc, and two unnumbered regions. Of the seven numbered regions, five carry a significant risk of flare activity, or have a recent history of significant flaring. AR3181 appears to have produced a large flare and CME as it approaches the western horizon, with a further M3.9 flare at 13/1015UTC. AR3182 is the other complex region in the western quadrant with significant flare risk, although AR3185 has also produced recent flares and potential CMEs. AR3186 is the most potent region in the northeast, having redeveloped a delta region, with AR3184 also high risk and continuing to spread and grow. Two new, numbered regions on the eastern limb, are demonstrating a brightness, indicating potential high magnetic flux and are likely to appear to be more complex as they rotate further into the visible disc.

Mainly Low to Moderate solar activity is forecast, with an increasing risk of M-class flaring through the period, the reduced activity from regions rotating off the western limb likely to be more than compensated for by the new regions in the east. There is also a continuing chance of X-class flares.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	70	80	80	80
Very Active	R3 to R5 X Class	No	20	20	20	20

Figure 4: GOES-18 X-ray flux

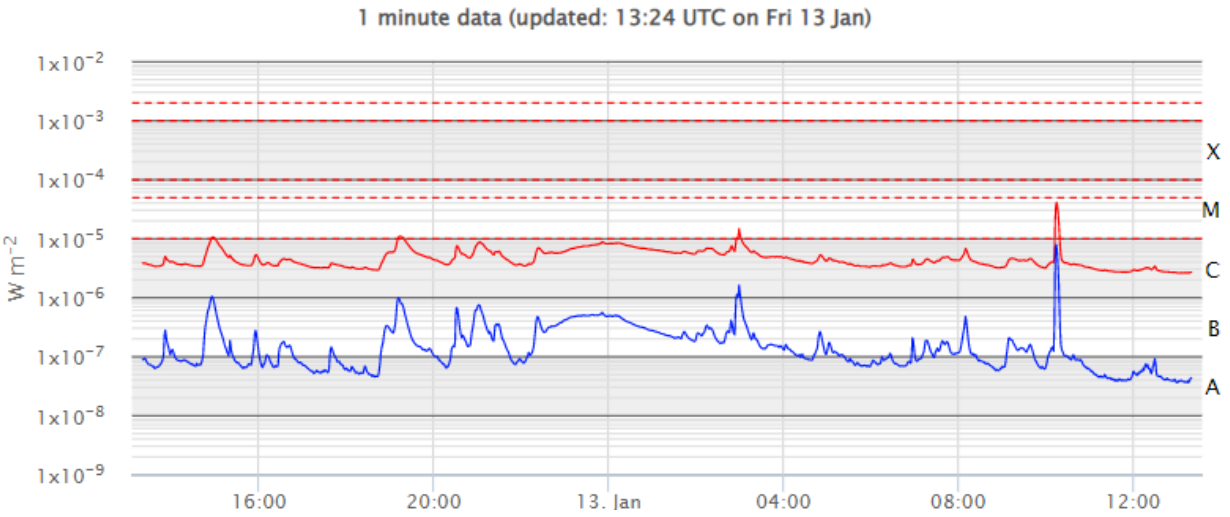

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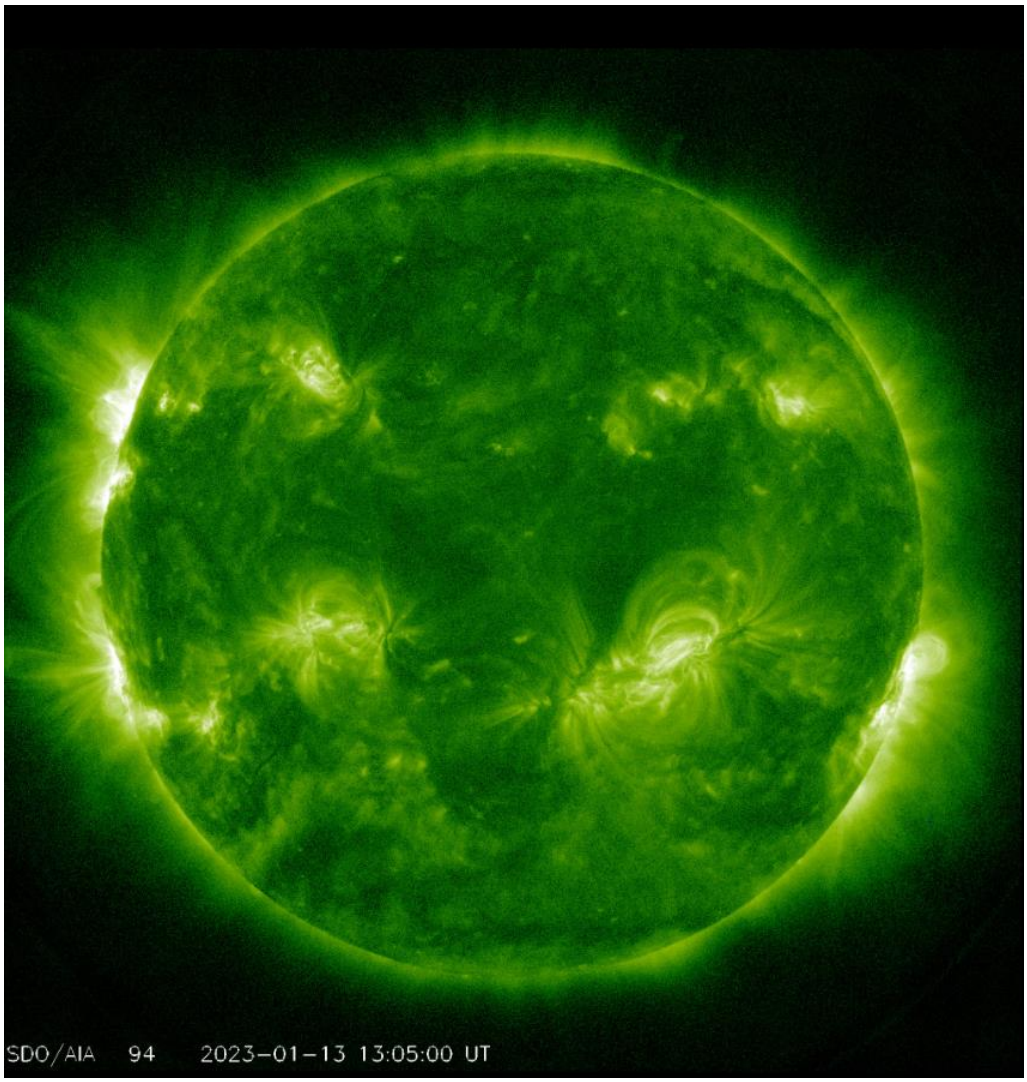
Figure 5: SDO AIA-94 imagery with the bright flux regions clearly evident



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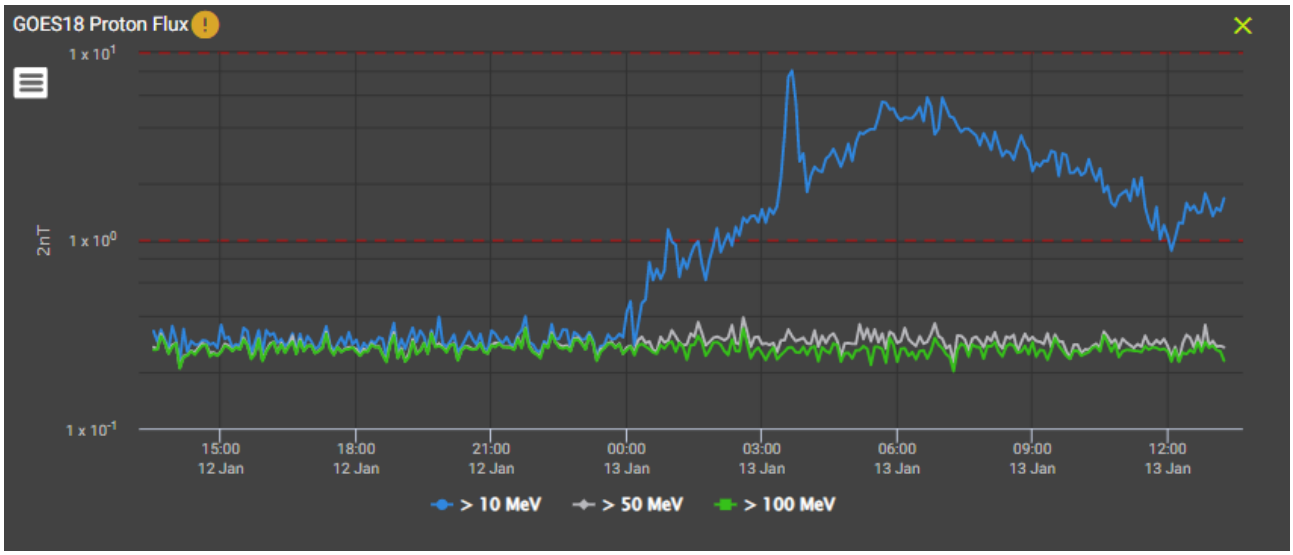
Solar Radiation Storms - (High Energy Protons):
The high energy (greater than 10 MeV) proton flux observed by GOES-16 has shown recent enhancements due to a CME from the southwestern limb. The risk of proton storming has been increased due to the history of this region, which could still produce Earth-directed proton storms from any elevated flares from over the western horizon. A complex region in the southwest quadrant and further complex regions approaching the centre disc all carry an elevated risk of proton storms from any energetic eruptions, helping to maintain the risk through the period. Proton flux is expected to be at background with a chance of minor levels through the next four days.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	40	40	40	40
Very Active	≥ S3 *	No	1	1	1	1

* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)

Figure 6: GOES-18 Proton flux



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High Energy Electrons Event (≥ 2MeV):
High energy electron flux (greater than 2MeV) is expected to be at mainly background to moderate levels over the next four days in the absence of a strong high speed stream, or any other modifying factors to enhance counts within the radiation belts.
Electron fluence values are well below the Active threshold and are likely to remain well below through the next four days.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	1	1	1
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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